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A QUALITATIVE POLICY ASSESSMENT

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ABSTRACT

Under the federal Clean Air Act Amendments of 1977, states must implement transportation system management (TSM) tactics in urban areas which have not attained national ambient air quality standards for carbon monoxide and photochemical oxidants. This paper provides a preliminary assessment of the effectiveness and feasibility of using TSM tactics to improve air quality. Based on this assessment, the authors conclude that TSM measures should be effective in eliminating localized carbon monoxide problems, but such measures are not likely to have an impact on regional oxidant levels in nonattainment areas. In addition, because most individual TSM tactics can have only marginal impacts on regional motor vehicle emissions, coordinating the planning and implementation of many TSM measures will be an essential element of an effective TSM program for improving air quality.

INTRODUCTION

Under the federal Clean Air Act Amendments of 1977, states are required to implement transportation controls in urban areas which have not attained national ambient air quality standards (NAAQS) for carbon monoxide (CO) and photochemical oxidants (Ox). Transportation controls refer to measures such as mandatory inspection and maintenance programs and transportation system management (TSM) strategies for reducing emissions from on-the-road motor vehicles. Controls of this kind must be implemented in those metropolitan areas which cannot rely solely on stationary source and new motor vehicle emission controls to meet air quality health standards by the 1982 Clean Air Act deadline. These areas may receive a five year extension to 1987, providing that the states demonstrate in their 1979 state implementation plans (SIP) that all reasonable transportation control measures are being considered for implementation in meeting the ambient standards.

Joint U. S. Environmental Protection Agency (USEPA) and U. S. Department of Transportation (USDOT) guidelines[1] for the transportation system elements of state implementation plans require that states utilize existing state and local transportation planning processes in developing a program of transportation controls. These controls must provide for incremental reductions in transportation system emissions as expeditiously as practicable. The guidelines stress implementation of all reasonable control measures, but particularly those that can be planned and implemented by 1982 or within the following five years. To this end, transportation planning agencies must consider complementing inspection and maintenance programs with a wide variety of so-called short-range, low-capital TSM strategies, e.g., mass transit improvements, preferential bus and carpool lanes, parking management, pricing, auto-restricted zones, and so on.

This paper provides a preliminary assessment of the feasibility of using TSM strategies to improve air quality. The assessment is preliminary in the sense that it is based on qualitative analyses of the motor vehicle emissions reduction potential of the various TSM strategies and of the technical and political feasibility problems of implementing TSM strategies by the 1982 deadline. In addition, these analyses were made without reference to any specific metropolitan region; therefore, many of the analytical conclusions that are drawn here may need modification in order to fit the individual circumstances of particular urban areas. Additional research that uses travel demand models to quantify the mobile source emissions impacts of TSM measures for specific urban areas is needed in order to make a final assessment of the effectiveness of the current TSM-air quality policy.

TSM STRATEGIES AND PLANNING FOR IMPROVING AIR QUALITY

The Clean Air Act Amendments of 1977 list several kinds of TSM strategies (Public Law 95-95, Section 105(f)) that states and metropolitan planning organizations (MPO) will be expected to evaluate for SIP requirements for nonattainment areas. The list of TSM measures in the Clean Air Act is similar to the list of measures identified in the joint Federal Highway Administration (FHWA) - Urban Mass Transportation Administration (UMTA) TSM planning regulations of 1975.[2] These regulations established a requirement for urban areas to develop TSM plans which document strategies for improving air quality, conserving energy, and increasing transportation system efficiency and mobility through coordinated operation and management of existing urban transportation facilities and services. The 1975 joint regulations are also important in that they set in motion at the local level the TSM planning process which USEPA now intends to utilize in meeting the air quality standard deadlines in the Clean Air Act.

The strategy sets in the Clean Air Act include many specific tactics for reducing motor vehicle emissions. A list of 13 strategy sets including 59 TSM tactics,[3] which closely correspond to the set of measures in the joint FHWA-UMTA regulations, is presented in Table 1. As indicated in the table, the strategy sets and tactics have also been grouped according to the specific means by which they achieve reductions in emissions: congestion reducing strategies, modal choice oriented strategies, and combination congestion reducing-modal choice oriented strategies. Although this list of tactics may be incomplete, it does contain most of the TSM measures that transportation planners are likely to evaluate in making the 1980 SIP revisions for nonattainment areas.

Tactics in the congestion reducing strategy sets are designed to increase the traffic handling capacity and operating speed of existing roadways. These tactics affect travel times for all vehicles, but are usually designed to improve vehicular flows at specific intersections, along major freeways and arterials, or in commercial areas. For example, turn lane installation increases intersection capacity; ramp metering facilitates movement onto freeways; and eliminating on-street loading of trucks improves traffic flow in the central business district (CBD).

Modal choice oriented tactics are designed to increase the relative attractiveness of using mass transit or high occupancy vehicles (HOV) in place of the single occupant auto. These tactics directly affect travel conditions for a specific class of vehicles, but they may act in a regionwide or destination-specific manner in changing travel demand patterns. Bus route and schedule modifications and park-and-ride facilities, for example, can be established to increase the mass transit ridership throughout an entire region. Express bus service and

TABLE 1. TRANSPORTATION SYSTEM MANAGEMENT STRATEGY SETS AND TACTICS

STRATEGY SET	TACTIC
Congestion Reducing Strategies	
Traffic Operations Improvements:	- Intersection and Roadway Widening - One-Way Streets - Turn Lane Installation - Turning Movement and Lane Use Restictions - New Freeway Lanes on Shoulders
Traffic Signalization Improvements:	- Signal Controller Improvements - Arterial Signal Systems - Area Signal Systems - Freeway Diversion and Advisory Signing - Ramp Metering
Commercial Vehicle Control:	- On-Street Loading Zones - Off-Street Loading Areas - Peak Hour Loading Prohibitions - Special Truck Route System
Work Schedule Modifications:	- Staggered Work Hours and Flex-Time - 4-Day Work Week
Modal Choice Oriented Strategies	
Pedestrian and Bicycle Facilities:	- Sidewalk Widening - Pedestrian Grade Separations - Bikeways - Bike Storage Facilities - Pedestrian Control Barriers
Roadway Assignment Tactics:	- Exclusive Bus Lanes - Bus-Only Streets - Contra-flow Bus Lanes - Reversible Lane Systems - Freeway HOV Bypasses - Exclusive Bus & HOV Freeway Lanes and Roadways
Route Diversion Tactics:	- Residential Traffic Controls - Area Auto Licensing - Pedestrial Malls - Auto Restricted Zones
Transit Operations Improvements:	- Bus Route and Schedule Modifications - Express Bus Service - Bus Traffic Signal Preemption - Bus Terminal Improvements - Simplified Fare Collection Schemes
Transit Management Improvements:	- Marketing Program Improvements - Maintenance Improvements - Vehicle Fleet Improvements - Operations Monitoring Programs
Intermodal Coordination Tactics:	- Park-and-Ride Facilities - Transfer Improvements
Paratransit Programs:	- Carpool Matching Programs - Vanpool Programs - Taxi/Group Riding Programs - Dial-A-Ride Programs - Jitney Service - Elderly and Handicapped Service
Combination Congestion Reducing and Modal Choice Oriented Strategies	
Parking Management Tactics:	- Curb Parking Restrictions - Residential Parking Controls - Off-Street Parking Restrictions - Preferential Rates for HOVs and Short-Term Parkers - Preferential Spaces for HOVs
Pricing Tactics:	- Peak Hour Tolls - Low-Occupancy Vehicle Tolls - Gasoline Tax Increases - Peak/Off peak Transit Fare Differentials - Elderly and Handicapped Fare Differentials - Transit Fare Reductions

carpool/vanpool matching programs, on the other hand, can be designed to induce modal shifts in travel to specific destinations within a region and/or during specific times.

Some modal choice oriented tactics are designed to increase transit and HOV ridership by reducing the attractiveness of using the automobile. Route diversion tactics, for example, can create congestion and increase travel times for individuals who wish to enter the restricted zones by auto. The establishment of exclusive bus and HOV freeway lanes may also increase low occupancy vehicle travel times if, in so doing, available roadway capacity for autos is reduced.

Tactics in the parking management and pricing strategy sets contain elements that are both congestion reducing and modal choice oriented. Curb parking restrictions and peak hour tolls, for example, are designed to reduce congestion, while preferential parking considerations for HOVs and reduced transit fares are designed to encourage modal shifts. These tactics can also be destination as well as travel time specific, or they can, as in the case of a regionwide gasoline tax increase, impact on all motorists within a region in the same manner.

Planning experience is greatest in implementing congestion reducing strategies. To a large extent, the tactics in the congestion reducing strategy sets of traffic operations and signalization improvements exemplify the kinds of changes that traffic engineers have long utilized as part of an ongoing process to improve highway transportation system safety, operations and efficiency. Tactics in the commercial vehicle control and work schedule modifications strategy sets represent newer congestion reducing proposals that will require an additional

element of coordination between transportation planners and labor unions, commercial establishments and industrial plants.

The congestion reducing effectiveness of tactics such as intersection and roadway widening and signal network modernization and control improvement was demonstrated in the 1960s and early 1970s by FHWA's areawide Traffic Operations Program to Increase Capacity and Safety (TOPICS). As a result of the success of the TOPICS demonstration program, consideration of traffic engineering improvements during the planning and programming stages became one of the building blocks of the federal TSM program which was established in 1975.[4] Implementation of traffic operations and signalization improvements currently absorbs the largest share of TSM planning efforts in many metropolitan areas.[5-8]

Federal planning experience in implementing modal choice oriented strategies began with the Urban Mass Transportation Act of 1964. In implementing modal choice oriented strategies, transportation planners have given the most attention to strategies which reduce the time and travel costs of mass transit and HOV modes relative to the costs of driving an auto. Tactics which have been widely implemented include establishing exclusive bus lanes, improving transit operations, building park-and-ride facilities and organizing carpool/vanpool matching programs. Planners have had considerably less experience in implementing those congestion creating and pricing tactics (e.g., auto restricted zones, area auto licensing, low occupancy vehicle tolls and charges and regional gasoline tax increases) which will encourage shifts to mass transit and HOV modes by increasing the relative costs of travel by auto.

Initially, UMTA programs consisted of providing capital grants for improving transit operations and management, but because of high federal outlays to finance these programs, a policy evolved within UMTA to encourage the use of short-term, low-capital-intensive traffic management techniques as a means of increasing mass transit ridership. In 1975, UMTA issued transit capital and operating assistance program interim guidelines,[9] which required local transportation planning agencies to indicate in grant applications an intention to adopt tactics such as establishing exclusive bus lanes, creating auto restricted zones, and restricting on and off-street parking. These guidelines wedded together traffic management tactics with UMTA's modal choice oriented programs and provided a second building block for the 1975 joint FHWA and UMTA TSM guidelines.[4]

THE MOTOR VEHICLE EMISSIONS REDUCTION POTENTIAL OF TSM STRATEGIES

In theory, the implementation of a successful TSM program can reduce motor vehicle emissions in three ways. Congestion reducing oriented strategies reduce emissions by increasing vehicular flow; CO and hydrocarbons (HC) emission rates will decline as cars are able to move more rapidly, but nitrogen oxide (NO_x) emission rates will increase. Modal choice oriented strategies reduce emissions by decreasing the number of trips made in single occupancy vehicles; emissions will decline as the number of cars on the road decreases. Vehicle travel oriented strategies reduce the utilization of single occupancy vehicles; emissions will decline as total vehicle kilometers of travel is reduced. Modal choice and vehicle travel oriented strategies also potentially reduce emissions by reducing congestion.

To examine the relative contributions that the implementation of different TSM strategies might make toward achieving air quality goals, each of the strategy

sets in Table 1 was analyzed to determine its potential for reducing corridor CO and areawide HC and NO_x emissions for motor vehicles. For CO, the emissions reduction potential was determined for both peak and offpeak driving periods. The results of this analysis are presented in Table 2.

The method for determining emissions impacts for each strategy involved first dividing the transportation demand process into the various travel elements for individuals; travel time, out-of-pocket travel costs, modal choice, trip length and trip frequency. Based on a literature review of observed and model-estimated travel impacts of TSM actions,[10-21] judgements were then made regarding the expected direction and magnitude of the personal and systemwide (mean speed and total vehicle kilometers travelled) travel demand impacts that would occur as a result of the implementation of each TSM strategy. Finally, the emissions reduction potential of each strategy was extrapolated from the direction and magnitude of its travel impacts. Although crude, this method provided a first approximation of the likely emissions impacts of a single TSM stragegy. The procedure of using travel demand impacts as a basis for systematically determining the emissions impacts of TSM strategies is essential even for the kind of preliminary analysis being presented here. The implementation of a specific TSM strategy may alter several travel demand elements in a manner which may have offsetting emissions impacts. The successful implementation of a carpool/vanpool program, for example, would result in a reduction in the number of work trips made in single occupancy vehicles and, hence, a reduction in peak period vehicle kilometers of travel (VKT). However, because increased use could be made of the vehicles that remain at home during the workday, regional VKT and vehicle emissions could remain the same or even increase somewhat.

TABLE 2

QUALITATIVE IMPACTS OF TSM STRATEGIES ON TRAVEL DEMAND AND MOTOR VEHICLE EMISSIONS

TRAVEL ELEMENTS	PERSONAL MOBILITY				MODAL CHOICE								TRIPS PER PERSON				SYSTEM IMPACTS				EMISSIONS		
					Public Transit				Private Auto/Van														
	Travel Time		Travel Cost		Fixed Route		Demand Responsive		High Occupancy		Low Occupancy		Mean Length		Mean Frequency		Mean Speed		Travel (VKT)		Corridor (CO)		Regional (NOx) (HC)
TSM STRATEGY SETS	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	P	OP	- -
Congestion Reducing Strategies																							
1. Traffic Operations	-M	N	N	N	N	N	N	N	N	N	N 1/	N	N	N	N	N	N/+M 2/	N	N 3/	N	N/+M	N	N
2. Traffic Signalization	-M	N	N	N	N	N	N	N	N	N	N 1/	N	N	N	N	N	N/+M 2/	N	N 3/	N	N/+M	N	N
3. Commercial Vehicles	-M	N	N	N	N	N	N	N	N	N	N 1/	N	N	N	N	N	N/+M 2/	N	N	N	-S	N	N
4. Work Schedules	-M	N	N	N	N/-M	N	N	N	N/-M	N	N/+M	N	N	N	-S	+M/+S	N/+M 2/	N	-M	+M/+S	N/-M	N/+M	-M/+M
Modal Choice Oriented Strategies																							
1. Pedestrians and Bicycles	N/-M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
2. Roadway Assignment																							
HOV/Bus	-S	N/-M	N	N	+M/+S	N	N	N	+M/+S	N	N/-M	N	N	N	N	N	+M/+S	N	N/-M	N	-M/-S	N	N
Auto	N/+M	N	N	N									N	N	N	N	N/-M	N					
3. Route Diversion	N/+M	N/+M	N	N	N/+M	N/+M	N	N	N	N	N/-M	N	N/+M	N/+M	N	N	N	N	N	N	-M/-S	N/-M	N
4. Transit Operations	-M	N/-M	N	N	N/+M	N/+M	N	N	N	N	N	N	N	N	N	N	N	N	N/-M	N	N	N	N
5. Transit Management	N	N	N	N	N/+M	N/+M	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
6. Intermodal Coordination	-M	N	N/-M	N	N/+M	N	N	N	N	N	N	N	N/+M	N	N	N/+M	N	N	N/-M	N	N/-M	N	N
7. Paratransit	+M/+S	N	-S	N	N/-M	N	N/+M	N/+M	+M	N	N/-M	N	+M/+S	N	N	+M/+S	N	N	N/-M	N/+M	N/-M	N	-M/+M
Congestion Reducing and Modal Choice Oriented Strategies																							
1. Parking Management	N	N	-M/+S	N/-M	N/+M	N	N	N	N/+M	N	N/-M	N	N	N	N	N	N 2/	N	N 4/	N	-M	N	N
2. Pricing	N	N	+M/+S	N/+M	N/+M	N/+S	N	N	N/+M	N	-M/-S	N/-M	N	N/-M	N	-M/+M	N/+M	N	N/-M	N/-S	N/-M	N	N/-S

1/ If congestion is a deterrent to auto travel, low occupancy auto mode may increase.
2/ Local speeds may increase.
3/ Local VKT may increase.
4/ Local VKT may decrease.

Key
N Negligible impact
M Moderate impact
S Substantial impact
\+ Increase
\- Decrease

P Peak period
OP Offpeak period
VKT Vehicle kilometers travelled

CO Carbon monoxide
NO_x Nitrogen oxide
HC Hydrocarbon

In Table 2, a minus sign indicates negative TSM travel and emissions impact, and a plus sign indicates positive impacts. The letter N indicates negligible impacts; M indicates moderate impacts; and S indicates substantial impacts.

The terms "negligible," "moderate," and "substantial" are used to provide a crude ranking of the relative importance of the travel and emissions impacts associated with each strategy. Negligible refers to impacts that were judged to be less than one percent; moderate refers to impacts in the one to five percent range; and substantial indicates impacts that were judged to be greater than five percent. These terms have meaning only within the context of comparing one TSM strategy to another, and the reader is cautioned against adding together the impacts listed in Table 2 and then comparing the emissions reduction potential combinations of TSM strategies to the potential of non-TSM transportation controls such as mandatory vehicle inspection and maintenance programs. As a point of reference, however, inspection and maintenance programs are expected to produce at least a 25 percent reduction in projected 1987 light duty vehicle exhaust emissions of hydrocarbons and carbon monoxide.[22]

In terms of an overall assessment, Table 2 indicates that the emissions reduction potential is negligible or moderate for a large majority of the TSM strategy sets. In addition, the emissions reducing impacts of many of the strategies are likely to be very localized and regionally confined to specific roadway segments or commercial areas. Furthermore, the emissions reduction potential of many strategies is also confined temporally because of their peak period travel orientations. These observations point to a central conclusion that effective transportation system management for reducing vehicle emissions will

necessarily require the implementation--in a regionally and temporally coordinated manner--of a large combination of tactics from several TSM strategy sets.

As indicated in Table 2, traffic congestion reducing strategies are most effective in increasing vehicular movement during the peak travel period when existing roadway space is utilized to capacity. As a result these strategies are likely to impact mainly on peak period CO emissions at specific locations along major arterials, on urban freeways, and in the CBD. Many traffic operations and signalization improvements are so localized in nature, however, that their CO emissions reduction potential is even more narrowly confined to specific intersections. Furthermore, there is substantial evidence[23,24,16] that traffic operations and signalization improvements attract additional traffic flows which may be large enough to bring about an increase in CO emissions within a short time after implementation. Of the congestion reducing strategies only work schedule changes appear to have the potential for reducing automobile travel demands sufficiently to impact moderately on transportation-related regional oxidant levels.

The emissions reduction potential of modal choice strategies depends greatly on the extent of current mass transit ridership levels. Modal choice strategies will bring about smaller reductions in emissions in those regions in which transit utilization rates are already relatively high. Because mass transit ridership rates tend to be highest during the peak periods, the emissions impacts of the peak period and/or destination specific modal choice oriented strategies will mainly consist of reducing corridor and CBD CO emissions. Most modal choice oriented strategies are not likely to impact on oxidants in metropolitan regions with well established mass transportation systems. In these regions,

only carpool/vanpool programs appear to have the potential for reducing the number of trips in single occupant vehicles sufficiently to impact moderately on transportation-related regional oxidant levels.

The emissions reduction protential of combination congestion reducing and modal choice oriented strategies also depends greatly on current mass transit ridership levels as well as on the spatial and temporal extent to which these strategies are eventually implemented. Parking restrictions or low occupancy tolls, for example, can be implemented only in a very localized manner and for peak period travel, or they can be implemented on a regionwide basis for all travel conditions. The emissions reduction impacts will, of course, be greater for the regionally and temporally more comprehensive combinations of tactics. With regard to regional and temporal comprehensiveness, only a program of pricing tactics, which includes regional gasoline tax increases, was judged as having the potential of being sufficiently stringent in impact and regional in scope to bring about a substantial reduction in regional transportation-related oxidant levels.

These conclusions must be qualified with respect to two assumptions that were made in determining the emissions reduction potential of each TSM strategy set. First, the impacts listed in each row of Table 2 are those that would be expected if each strategy set were implemented alone. This analysis did not attempt to determine the emissions reduction potential of combinations of TSM strategy sets; hence, it did not identify any tendencies for strategies to reinforce or counteract each other in reducing emissions. Such tendencies clearly exist as in the reinforcing of work schedule modifications by transit schedule changes or in the counteracting of vehicular flow improvements by bus only lanes,

for example. The use of transportation demand models is required to determine the net influence of combinations of TSM strategy sets on motor vehicle emissions.

Second, it was assumed that the 13 TSM strategies were being implemented in an urban area where the current TSM program is relatively underdeveloped. In other words, the impacts are those that would be expected if each strategy set were implemented in a relatively virgin setting. This assumption is definitely inappropriate for those metropolitan regions that have made extensive use of one or more TSM strategies. For these regions, the impacts in Table 2 must be modified accordingly. Here too, the extent to which an existing TSM program has already taken advantage of a region's potential for utilizing a particular strategy can only be assessed with a transportation demand model that reflects local conditions.

IMPLEMENTATION FEASIBILITY OF TSM STRATEGIES

There are several technical and political considerations that are likely to facilitate or impede the implementation of TSM measures for the purposes of reducing mobile source emissions. Some of these are general considerations and relate to the overall responsiveness by MPOs to the federal TSM program. Others concern more specific transportation-related factors such as personal mobility, transportation cost and public acceptability.

To begin with, any set of statements regarding the feasibility of implementing a coordinated set of TSM measures for improving air quality must necessarily be speculative at this time. The TSM program as promulgated in the joint UMTA-FHWA regulations is barely three years old. MPOs are not yet experienced in implementing many of the potential TSM tactics, and the full extent of the

feasibility of using certain individual tactics or combinations of tactics has yet to be determined.

Because of the newness of the program, and because of difficulties in interpreting the federal regulations, the TSM planning philosophy of using a full complement of short-range and low-cost transportation management options to improve system operations and efficiency is just beginning to permeate MPO planning procedures. Although these procedures have for many years included some TSM tactics, most notably the traffic management tactics, the concept of coordinating a large number of tactics into an integrated plan for achieving systemwide improvement is just beginning to emerge. This concept will be essential in using TSM effectively to improve air quality because most individual TSM tactics are expected to have only marginal impacts on systemwide vehicle emissions.

Based on a review of two years of planning experiences, Gakenheimer and Meyer[4] assessed MPO responsiveness to the federal TSM program. Many of the factors which were identified as having an impact on local area response to TSM policy will undoubtedly influence local TSM planning for emissions reductions. Some of the factors whose influence on planning will be fairly straightforward include:

1. A tendency by the MPO to favor TSM options that are represented by funded programs.
2. A tendency for agencies to be less agreeable to building a strong TSM process where there is a considerable amount of high capital construction yet to be completed.
3. A greater likelihood that TSM planning will be more effective where there are comprehensive metropolitan governments, which internalize relations between local jurisdictions.

There are several transportation-related factors which can be used as indicators of implementation feasibility. These include mobility impacts on automobiles; capital and operating cost increases; administrative and technical enforceability problems; barriers to public acceptability; and legislative and other governmental requirements.

Of these, impact on an individual's use of the automobile is in all likelihood the single most important indicator of implementation feasibility. Table 3, which summarizes the authors' judgements regarding the implementation feasibility of the 13 strategy sets with respect to the five indicators mentioned above, indicates a strong correlation between the impact that a strategy will have on automobile mobility and its public acceptability. Those strategies which tend to improve travel conditons for single occupant autos and/or provide more options for commuters (e.g., carpool/vanpool programs, express buses or traffic operations improvement) are likely to meet with greater public acceptance. Those strategies which restrict the ease of an individual's opportunity for using the automobile (e.g., pricing strategies, parking restrictions, roadway assignment and auto restricted zones) are likely to meet with poor public acceptance.

Impact on the costs of travel by automobile is another key indicator for judging implementation feasibility, but impacts on direct out-of-pocket costs are probably much less important than mobility impacts because urban travellers typically view non out-of-pocket, mobility-dependent, time costs as being the most important element of travel costs. Although the vehicle operating costs--gasoline, parking and tolls--that would be impacted by TSM pricing strategies represent a small fraction of total driving costs, individuals and decision makers perceive these costs (especially gasoline) as the major expenses borne

TABLE 3

IMPLEMENTATION FEASIBILITY OF TSM STRATEGY SETS

TSM STRATEGY SET	AUTO MOBILITY IMPACTS	CAPITAL AND OPERATING COST IMPACTS	ADMINISTRATIVE AND TECHNICAL ENFORCEABILITY	PUBLIC ACCEPTABILITY	INSTITUTIONAL REQUIREMENTS
Congestion Reducing Strategies					
Traffic Operations	Improves auto mobility.	Public sector bears costs. Program costs are low relative to new construction.	Little administrative and technical enforcement required.	Public acceptance already exists.	Problem exists with getting funds due to backlog of previously committed projects.
Traffic Signalization	Improves auto mobility.	Public sector bears costs. Program costs are low except for ramp metering and advisory signing.	Little administrative and technical enforcement required.	Public acceptance already exists.	Problem exists with getting funds due to backlog of previously committed projects.
Commercial Vehicles	Improves auto mobility.	Private sector bears some of the costs. Public pays for truck route development.	Private interests must administer new delivery hours, places, and routes.	Resistance is likely from unions, stores.	Legal changes to require off-street loading may be required.
Work Schedules	Improves auto mobility indirectly.	Private sector bears most of the costs.	Administrative difficulties exist for certain firms.	Management and unions may resist implementation. Potential for public acceptance exists.	
Modal Choice Oriented Strategies					
Pedestrians and Bicycles	Increases non-auto option.	Public sector bears costs. Costs can be low.	Little technical adjustment is needed.	Barriers exist to people who can or will not use facilities. No strong tendency for public acceptance exists.	
Roadway Assignment	Detrimental to auto mobility. Increases non-auto options.	Public sector bears costs.	Enforcement and safety problems can occur.	If project is well-planned and integrated, potential for public acceptance is high.	
Route Diversion	Restricts auto mobility and general access.	Public and private sectors share cost burden. Malls require large capital costs.	Enforcement may be difficult.	Interest groups may resist program. Potential for public acceptance exists if well planned.	
Transit Operations	Increases non-auto options.	Public sector bears portion of costs through subsidies.	Transit authority must administer program. Technical requirements are not major.	Program may be successful in attracting riders. Program has some public acceptance potential.	Funding can be difficult. Application process is time consuming.
Transit Management	Increases non-auto options.	Public sector bears portion of costs through subsidies.	Transit authority must administer program. Technical requirements are not major.	Program may be successful in attracting riders. Program has some public acceptance potential.	Funding can be difficult. Application process is time consuming.
Intermodal Coordination	Increases non-auto options.	Public sector bears portion of costs through subsidies. Costs are low, especially if dual purpose park-and-ride lots are used.	Transit authority must administer program.	Sound planning and integration is required to develop public acceptance.	
Paratransit	Increases non-auto options. Increases options of mobility limited people.	Public or private sectors bear costs depending on the individual tactic.	Administrative agency is required.	Public acceptance potential may be limited.	Legal changes at the interface of public-private transportation may be required.
Congestion Reducing and Modal Choice Oriented Strategies					
Parking Management	Detrimental to auto mobility.	Public and private sectors share the cost burden. Costs are fairly low.	City must administer program.	Impacts are limited because of private ownership of parking lots and different types of lots.	Legislative action is usually required.
Pricing	Detrimental to auto mobility.	Public and private sectors bear costs differently, depending on the tactic.	Pricing as implemented and administered would differ from from marginal cost pricing.	Pricing tends to be unpopular and political resistance is likely.	Legislative action is required.

by drivers. Consequently, the significant element of the cost indicator of feasibility is not "how much" but whether or not drivers will pay directly any of the additional expense. Those TSM strategies which result in larger out-of-pocket expeditures for individual drivers will be less acceptable to the public and decision makers than those strategies which can be paid for through public expenditures.

Of the remaining feasibility indicators, administrative and technical enforceability and barriers to public acceptability relate more to specific TSM strategy sets, while institutional requirements refer to enacting needed legislation or establishing comprehensive governmental units to remove impediments to TSM strategy coordination. Ease of preventing access by autos, for example, is particularly important in insuring the effectiveness of the roadway assignment and route diversion strategies. Resistence by unions and commercial interests may, for example, present barriers to the public acceptance of commercial vehicle controls or work schedule modifications. Finally, the inability of fragmented governmental units to coordinate in a regionwide manner the implementation of many of the strategy sets, e.g., traffic operations and signalization improvements, work schedule modifications, roadway assignment, route diversion, transit operation and management improvements, intermodal coordination and parking management programs, and pricing schemes, will greatly reduce their effectiveness.

SUMMARY AND CONCLUSIONS

Although the Clean Air Act Amendments of 1977 improved USEPA's ability to enforce the use of transportation controls in nonattainment areas, state and local authorities must confront several problems of coordination and public

acceptance in order to implement effective TSM programs for improving air quality. These problems will arise because many of the TSM actions that local authorities are likely to implement can have only marginal impacts on motor vehicle emissions. Therefore, combinations of many different TSM tactics will be needed to reduce emissions sufficiently to meet the air quality standards and coordinating the planning and implementation of these diverse tactics will be an essential element of an effective TSM program.

Many individual TSM tactics do not have the regional and/or temporal scope to impact significantly on regionwide vehicle emissions levels. The emissions reduction potential of nearly all of the tactics in the traffic operations and signalization improvements, commercial vehicle controls, roadway assignment, route diversion, intermodal coordination, and transit operations and management improvements strategy sets is directed toward reducing emissions along specific roadway segments and in commercial areas. As a result, the primary air quality impacts which can be expected from the implementation of these tactics will be the elimination of CO hotspots on major arterials, along freeways, and in the CBD. These tactics have little or no potential for reducing regional transportation-related oxidant levels.

The tactics in the above strategy sets also have the highest probability of being implemented by local authorities. Local transportation planners should favor many of the traffic control and transit operations improvement strategies in particular, because they have had considerable experience in implementing them. In addition, these tactics have positive or neutral impacts on automobile mobility, making them generally acceptable to the public.

Tactics in the work schedule modifications, paratransit, and pricing strategies have the potential for reducing vehicle emissions on a regional scale. If implemented on a regionwide basis, these tactics could reduce automobile travel demands sufficiently to impact on regional transportation-related oxidant levels.

It is unlikely that local authorities will be able to implement work schedule modifications, paratransit or pricing tactics in a regionally comprehensive manner within the required SIP deadlines. Local transportation planners lack experience in working with these tactics in general. Specifically, planners need assistance in coordinating work schedule changes among commercial and industrial establishments and in organizing regional carpool/vanpool matching programs. Pricing tactics are, of course, likely to be very unpopular, but without coordination among intergovernmental units they will also be ineffective.

In conclusion, TSM measures should be effective in eliminating localized CO problems, but such measures are not likely to have an impact on regional oxidant levels in nonattainment areas. To achieve reductions in transportation-related oxidants, local authorities must implement--in a regionally and temporally coordinated manner--a large number of diverse TSM tactics. Unfortunately, in many metropolitan areas, local transportation planners are likely to begin regional TSM program development by working with those tactics which have the lowest potential for reducing vehicle emissions on a regionwide basis.

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